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SECOND REVISED SUBMISSION – FINAL

Unemployment and suicide in Italy: evidence of a long-run association mitigated by public unemployment spending

Abstract

From the mid-1990s on, the suicide rate in Italy declined steadily, then apparently rising again after the onset of the Great Recession, along with a sharp increase in unemployment. The aim of this study is to test the association between the suicide rate and unemployment (i.e., the unemployment rate for males and females in the period 1977-2015 and the long-term unemployment rate in the period 1983-2012) in Italy, by means of co-integration techniques. The analysis was adjusted for public unemployment spending (referring to the period 1980-2012). The study identified a long-run relationship between the suicide rate and long-term unemployment. On the other hand, an association between the suicide and unemployment rate stemmed out, though statistically weaker. A 1% increase in long-term unemployment increases the suicide rate by 0.83%, with a long-term effect lasting up to eighteen years. Public unemployment spending (as percentage of the Italian Gross Domestic Product) may mitigate this association: when its annual growth rate is higher than 0.18%, no impact of unemployment on suicide in detectable. A decrease in the suicide rate is expected for higher amounts of social spending, which may be able to compensate for the reduced level of social integration resulting from unemployment, helping the individual to continue to integrate into society. A corollary of this is that austerity in times of economic recession may exacerbate the impact of the economic downturn on mental health. However, a specific ''flexicurity'' system (intended as a combination of high employment protection, job satisfaction and labour-market policies) may have a positive impact on health.

Introduction

In Italy, data available from 2000 onward show that every year more than 3,000 men and about 900 women commit suicide, thus indicating that every day about eleven suicides occur. This phenomenon is characterized by geographical disparities, with the North-East of the country presenting higher standardized suicide rates than the South (8.3 vs. 4.5 per 100,000 in 2014) [1]. From the mid-1990s on, a steady decline was recorded in suicide rates, that seems to have slowed down after the onset of the Great Recession (Fig.1). Though in 2015 the standardized suicide rate was lower than in 1995 (8.1 vs. 6.5 per 100,000), the steady increase noticeable between 2007 and 2013 is worthy of attention. In fact, in the same period Italy experienced the worst decline in GDP in peacetime, due to the most severe economic recession affecting the world economy since the

1930s [2]. As a result, it may be hypothesized that the economic turmoil may have impacted on the health of the Italian population.

Scientific investigation into the link between the socio-economic situation and suicidal behaviour dates back to the French sociologist Émile Durkheim, who published his essay *Suicide* in 1897 [3], pointing out that periods of economic crisis and, to a lesser extent, economic boom, increase suicide rates. Since then, similar findings have been reported from research carried out during the twentieth century [4-8], generally confirming Durkheim's observations, including those pointing to a pro-cyclical relation between suicide and economic developments [9, 10].

Though it is widely recognized that periods of financial hardship may be accompanied by increased suicide rates, it should be noted that some inconsistent results are to be found in the literature. On the one hand, several authors have pointed to this association [11-18]; on the other, other authors have questioned it [19] or reported no association at all in some countries [20-24]. Such mixed results and inconsistencies may be explained by the heterogenity of the statistical methods used, not always appropriate for the type of data included in the analyses [25, 26].

[Please display Figure 1 about here]

Econometric analysis is problematic due to some features of suicide and unemployment rates. Unit-root features frequently affecting such measures make them unfit for the inclusion in Ordinary Least Squares (OLS) regressions, due to the risk of spurious associations [18, 25, 27]. As a result, co-integration techniques are useful to overcome such limitations, when dealing with time series data. Adopting this statistical method, Ceccherini-Nelli and Priebe [25] identified unemployment as a major determinant of suicide rates, even in the long-run and in different countries (Italy, France, the UK, and the US).

Another reason that may explain the inconsistencies in the literature on this topic concerns the use of either the unemployment rate or the long-term unemployment rate as the main macro-economic indicators. While the majority of studies in the literature used the unemployment rate, a minority of them included the long-term unemployment rate in the analysis. However, it is well known that the long-term rate is associated with an increased risk of suicide, particularly in the first five years after job loss, and that this risk can persist for up to sixteen years [28]. This is significant, since mental disorders significantly increase the risk of suicide, and a strong correlation has been reported between mental health and long-term unemployment [29-32].

A third reason that may explain the inconsistencies in the literature is the fact that in many studies the analysis was not adjusted for social protection measures, which may mitigate the impact of economic crises on suicide [12, 33]. Stuckler et al. [12], in their seminal work, pointed out that an investment in active labour market programmes exceeding 10 USD per person is able to reduce the effect of unemployment on suicides by 0.038%.

The aim of the present study is to test the association between the suicide rate and unemployment (considering the unemployment rate for both males and females, and the long-term unemployment rate) by means of co-integration techniques. Our hypothesis was that suicide is influenced by changes in unemployment in the long run. We are aware that other studies in the literature are available, addressing a similar research question. However, such studies do not include data concerning the Great Recession, and focus mainly on the unemployment rate, rather than the long-term unemployment rate. Ceccherini-Nelli and Priebe collected data for Italy for the period 1970-

2001 [25], while Stuckler et al. collected data referring to mortality in 1970-2003 (including 2006) [12]. Our intention was to fill this gap, by extending the analysis, thus including the Great Recession and the subsequent years of severe economic crisis, as well as data concerning social protection measures.

Methods

Data collection

From the Organisation for Economic Co-operation and Development (OECD) Statistics (https://data.oecd.org/) we extracted the following data for Italy: male and female suicide rates (for the period 1977-2015), male and female unemployment rates (1977-2015), long-term unemployment rate (1983-2012), public unemployment spending expressed as a percentage of Gross Domestic Product (GDP) (1980-2012). According to the OECD, "Long-term unemployment refers to people who have been unemployed for 12 months or more. The long-term unemployment rate shows the proportion of these long-term unemployed among all unemployed." [34] On the other hand, "Public unemployment spending is defined as expenditure on cash benefits for people to compensate for unemployment. This includes redundancy payments from public funds, as well as the payment of pensions to beneficiaries before they reach the standard pensionable age, if these payments are made because the beneficiaries are out of work or for other labour market policy reasons. This indicator is measured in percentage of GDP." [35]

All data were transformed into their natural logs.

Statistical analysis

To study the relationship between the suicide rate and unemployment we test the following model:

$$S_t = \alpha + \beta UR_t + \varepsilon_t \quad (1)$$

where S is the *log* of the suicide rate, and UR is the *log* of the unemployment rate or the *log* of the long-term unemployment rate (depending on the econometric specification estimated), and ε is a residual.

Eq. (1) describes the long-run relationship between the suicide and the unemployment rate; β is the long run-elasticity, since all series are in logs. As detailed below, S and UR are non-stationary variables, i.e., they contain a unit root: this may invalidate conventional statistical inferences. Hence, we analyse the integration properties of S and UR by means of the Augmented Dickey–Fuller (ADF) test. This test does not make it possible to reject the null hypothesis of non-stationarity for the levels and stationarity for the first differences of all the series, which are I(1).

Although non-stationary series tend to vary over time without returning to a constant mean, economic and/or social forces should not allow these variables to vary except in a permanent way. In other words, these series share a common path of growth and at least one of them adjusts to deviations from the long-run path. In our case, if there is a long-run relationship between S and UR, movements in UR induce movements in S, and the disequilibrium from the long-run path is transitory. Co-integration offers one method to check whether eq. (1) holds. If there is a positive long-run path between S and UR, the estimated residual ε_t in eq. (1) will be stationary, i.e. I(0). In

this case, S and UR share a common stochastic and deterministic trend (*deterministic co-integration)* [36].

If deterministic co-integration is not found, we also check for a less stringent concept of long run relationship implicit in the definition of *stochastic co-integration* [36]. If stochastically co-integrated, S and UR share a common stochastic trend but different deterministic trends. We test for stochastic co-integration by means of the following specification:

$$S_t = \alpha + \beta UR_t + \phi trend + \varepsilon_t \quad (2)$$

If S and UR are related in the long run as, for example, in eq. (1), the latter represents an equilibrium relation; therefore, if these variables (S and U) deviate from this relation, some forces must bring them back to the equilibrium. This can be represented by a simple Error Correction Model, (ECM) as follow

$$\Delta S_t = \delta(S - \alpha - \beta UR)_{t-1} + \xi_t$$

If a macroeconomic shock hits UR by diverting it from the long run relation with S, then ΔS_t move in the opposite direction to restore the long run path. Changes in ΔS_t depend on the magnitude of the deviation from the equilibrium, and parameter δ is the velocity of the adjustment to this long run path. δ must be negative and statistically significant to ensure that the dependent variable ΔS_t adjusts to restore an equilibrium between the variables at time t-1.

The rate of growth of the suicide rate ΔS_t generally depends on its past ΔS_{t-1} and on the past changes in unemployment rate, ΔUR_{t-j} . In this case the ECM takes the following representation:

$$\Delta S_t = \sum_{i=1}^{m} a_i \Delta S_{t-i} + \sum_{j=1}^{n} b_j \Delta UR_{t-j} + \delta\left(S - \alpha - \beta UR\right)_{t-1} + \zeta_t \quad (3)$$

ΔS_t may also depend on exogenous variables as the rate of growth of public unemployment spending; in this case $\Delta EXPUN_{t-p}$ is included in eq. (3). We also consider an interaction term $(\Delta EXPN_{t-s} * \Delta UR_{t-s})$ taking into account a non-linear relationship between $\Delta EXPUN$ and ΔUR. In this case, the ECM is as follows

$$\Delta S_t = \sum_{i=1}^{m} a_i \Delta S_{t-i} + \sum_{j=1}^{n} b_j \Delta UR_{t-j} + \sum_{p=1}^{q} c_p \Delta EXPN_{t-p} + \sum_{s=1}^{r} c_p (\Delta EXPN_{t-s} * \Delta UR_{t-s}) + \delta\left(S - \alpha - \beta UR\right)_{t-1} + \upsilon_t \quad (4)$$

To estimate these ECM models, it is possible to use different econometric procedures, e.g., the two-step procedure by Engle and Granger and the multivariate Johansen method[1]. The Engle and Granger procedure estimates firstly the long run equation (first stage), while in the second stage the ECM is estimated inserting the first stage regression. Differently, in this study we use the multivariate procedure outlined by Johansen [37] that *jointly* estimate the short run dynamics, i.e., the following terms: $\sum_{i=1}^{m} a_i \Delta S_{t-i}, \sum_{j=1}^{n} b_j \Delta UR_{t-j}, \sum_{p=1}^{q} c_p \Delta EXPN_{t-p}$, and the long run relationship $S - \alpha - \beta UR$.

[1] See Stock and Watson [36] for details.

Results

Table 1 presents the outcome from the integration analysis. ADF tests of unit root (OLS) confirm that all variables are I(1): their p-values (in parenthesis) do not permit to reject the null hypothesis of unit root in all the series.

[Please display Table 1 about here]

Table 2 presents the co-integration results from the ECM in eq.3, but with different long-run regressions stated by eqs. (1), (2). The VAR lag length used to test for co-integration is selected by information criteria: AIC, BIC and HQC[2]. The criteria used to achieve the optimal lag structures are indicated in the Table.[3]

Suicide and unemployment rates do not share a long run-path even after controlling for gender. More precisely, for these series the deterministic co-integration is rejected even when male and female groups are considered. We also test for a less stringent concept of long-run relationship implicit in the definition of *stochastic co-integration*. The outcome is that the total suicide rate and the total unemployment rate comove in the long run controlling for different deterministic behaviours of the series. For the female group, there is also stochastic co-integration, while for the male group there is mixed evidence depending on the lag length selected: a VAR(2), selected by BIC and HQC, indicates no deterministic co-integration, while a VAR(5), selected by AIC, states co-integration.

We conclude that there is evidence of a long run-relationship between suicide and unemployment rate, both for males and females, but with a prevalence of the weak version of co-movement implicit in the concept of stochastic co-integration.

On the other hand, there is deterministic co-integration when the long-term unemployment is considered. This implies that suicide and long-term unemployment rates strictly comove in the long run. The corresponding cointegrating regression, estimated by an ECM as in eq.3, is the following:

$$S_t = 0.47 + 0.83 LTUR_t + \varepsilon_t$$

which states that a 1% increase in long-term unemployment increases suicide rate by 0.83%.

[Please display Table 2 about here]

Figure 2 shows the dynamic response of the suicide rate to a one-standard-error shock in the long-term unemployment rate. The effect is significant and long lasting over an eighteen-year forecast

[2] In the Johansen procedure, ECM models are estimated from a vector autoregression representation of the variables (VAR). For this reason in this section we refer to the VAR lag length to test for cointegration. Note that there is a correspondence between the VAR lag structure and the lags in the ECM. For example a VAR(2), i.e, a model with two lags, corresponds to an ECM (1), i.e., with one lag in the variables. AIC: Akaike information criterion; BIC: Schwartz information criterion; HQC:Hannan-Quinn criterion.

[3] The convergence to a particular lag structure depends on the parametrization of the starting model used, hence we use a reduction strategy from a VAR(5) to VAR(2) to choose the final VAR lag length. This reduction strategy is available upon request to the authors. When there is no convergence in indicating the lag length, Table 2 shows the co-integration results for all VAR models suggested by each criterium or combination of criteria.

period. This is due to the co-integration result: shocks to the long run path of the variables have permanent effects.

[Please display Figure 2 about here]

Table 3 outlines the findings from the ECM in eq. 3 and eq. 4 estimated by Johansen procedure. In both ECM models, δ, i.e., the velocity of the adjustment to the long run path of the variables, is statistically significant (5%) and with the expected sign (negative). This ensures that the growth of the suicide rate at time t, ΔS_t , significantly adjusts to restore the effects of a disequilibrium at time t-1 between the suicide rate and the long-term unemployment.

[Please display Table 3 about here]

Table 3 also shows that the growth of the suicide rate ΔS_t has a strong persistence, i.e., it depends significantly on its past ΔS_{t-1} (1% significance level), while the rate of growth of the long-term unemployment $\Delta LTUR_{t-1}$ is only significant at 10%. The growth of the public unemployment spending $\Delta EXPUN_{t-1}$ is not significant, but what is statistically relevant is its interaction with $\Delta LTUR_{t-1}$. In fact, the interaction term ($\Delta EXPUN_{t-1} * \Delta LTUR_{t-1}$) is significant at 1% significance level. Now the marginal effect of the growth of long-term unemployment on the growth of the suicide rate depends on the growth of the public unemployment spending in the following way

$$\frac{\Delta S_t}{\Delta LTUR_{t.-1}} = 0.26 - 1.44 \Delta EXPUN_{t-1}$$

This marginal effect suggests that when the growth of long-term unemployment increases by 1%, the growth of the suicide rate also increases by 0.26%, but this effect diminishes for increasing spending amounts thanks to the estimated negative sign of $\Delta EXPUN_{t-1}$.

It is also possible to calculate the *turning point* of this non-linear relationship between $\Delta LTUR_{t-1}$ and $\Delta EXPUN_{t-1}$ placing the derivative equal to zero. The turning point states that for values of $\Delta EXPUN_{t-1}$ equal to 0.18%, the estimated negative effect of $\Delta LTUR_{t-1}$ on ΔS_t (equal to 0.26) is cancelled. To give an example, in Table 4 we present different marginal effects of a long-term unemployment increase (equal 1%) for different values of growth of the public unemployment spending, possibly able to reduce the annual growth of the suicide rate, according to our findings.

[Please display Table 4 about here]

Discussions and conclusions

In the present study we found that long-term unemployment impacts on suicide. Moreover, a long-run relationship stems out when the suicide rate and unemployment rate are used, but this link is statistically weaker. Such differences may be due to having considered a different time span, as well as the use of two macroeconomics indicators, i.e., the unemployment rate and long-term

unemployment rate. Notably, the long-term unemployment rate was rarely used in studies that failed to detect an association between unemployment and suicide, yet we believe it should be routinely included in studies in this field. In fact, though a positive relation exists between the unemployment rate and long-term unemployment [39], the incidence of mental disorders such as major depressive disorder increases with the duration of unemployment. In other words, the longer the period of unemployment, the higher the risk of mental disorders, peculiarly those that are well-recognized risk-factors for suicide.

In the light of the above, it is possible to conceive an initial psychological mechanism, already outlined and frequently referred to in the literature, that may help cast light on the relation between suicide and long-term unemployment identified in our study. At the same time, a second mechanism may be hypothesized that is sociological rather than psychopathological or psychodynamic. To understand this, it should be borne in mind that from 1983 to 2012, the mean long-term unemployment rate in Italy (as a percentage of overall unemployment) was 59% (ranging from 69.8% in 1990 to 44.6% in 2009), thus indicating that about one out of two unemployed persons continued to be out of work for at least twelve months. Such figures clearly indicate the importance of this phenomenon in our country, though unemployment has been a crucial issue in most countries of the European Union since the early 1990s, with significant premature mortality costs [40-42]. It seems likely that the longer the period of unemployment, the fewer social contacts the individual has. In other words, longer unemployment is associated with a lower level of social integration. Notably, this reduced level of social integration may be compared to the concept of autism featuring the worst depressive conditions (i.e., the psychotic ones), first cited by the Swiss psychiatrist Eugen Bleuler in his essay on schizophrenias (though autism features all types of psychotic disorders) to indicate a state of "detaching oneself from outer reality along with a relative or absolute predominance of inner life" [43]. Whether caused by a severe depression featured by depressive autism following unemployment or by unemployment *per se*, the reduced level of integration in society was recognized by Durkheim as one sociological cause of suicide, which he named *egoistic*, to indicate the condition of loneliness and detachment from the social network [3]. It may also be conceptualized as a condition of reduced individual social capital, intended as individual resources deriving from the relational networks in which the individual acts, and represented by all social relations a person can use to fulfil his/her personal aims [44, 45]. *The crucial part played by social protection as a factor able to mitigate the negative impact of long-term unemployment on suicide may be due to its ability to compensate for the reduced level of social integration resulting from unemployment.* In other words, it may enable the individual to remain more closely connected to society. In addition to this sociological explanation, from the psychological standpoint social protection may mitigate the loss of self-esteem caused by unemployment, reduced income, and the changes in personal and family life that frequently occur after job loss.

The sociological mechanism should also include another possible expanation, concerning the concept of *anomie*, used by Durkheim to indicate a state of reduced social norms and regulations [3]. Society may be conceived not only as a complex network of relations, but also as a sort of 'power' regulating such relations. Periods of change, such as economic recessions, may be a sign of reduced social regulation, for the fact of being *crises*, i.e., turning points. This seems a possible way to understand the recent financial crisis: not simply as an economic recession, but rather as a social, economic, cultural, and political turning point (the "crises of market greed", [46]), thus leading to high levels of anomie. Not surprisingly, long-term unemployment increases in times of economic downturn. This was the case in Italy after the crisis of the early 1990s, when long-term unemployment increased from 57.7% of total unemployment in 1993 (the lowest since 1983) to 66.3% in 1997. The same can be noticed after the onset of the late 2000s financial crisis, which

increased the risk of poor mental health and unemployment, especially among people affected by mental disorders [47, 48, 49]. In 2009, long-term unemployment was 44.6% of total unemployment (the lowest record available); after the onset of the European sovereign debt crisis in 2010, it increased to 61.4% in 2014. Even in this case, increased social expenditure can help reduce anomie in society, and its effect on suicide rates. As a corollary, austerity measures in times of recession may worsen anomie, as well as the individual's level of integration, already reduced by the state of unemployment. In both cases, suicides may increase. On the other hand, a specific ''flexicurity'' system (intended as a combination of employment protection, job satisfaction and active labour-market policies) could impact positively on health [32].

Some major limitations affecting the present research need to be acknowledged. First, due to the study design and the statistical techniques adopted, it is not possible to establish causality. In other words, the presence of co-integrations does not mean that long-term unemployment causes suicides. However, in line with the literature, we point out that social protection plays a crucial role, as a factor to mitigate this association, even in Italy. Second, it was not possible to establish whether people who committed suicide were already affected by a psychiatric disorder before unemployment. Still, we believe that unemployment should be considered first and foremost a measure of social change affecting the individuals' level of integration within society and the level of anomie. In other words, rather than being a *cause*, unemployment may be a *measure* of certain social phenomena. Third, we did not include other variables that may be of interest, such as consumer confidence, at the macroeconomic level, or social expenditure for housing projects or active labor market programmes, at the social protection level. Other studies aiming to overcome such limitations are currently on our research agenda. Fourth, we are aware that the analysis adopted may be too parsimonious, suffering from size distortions [50]. At the same time, other studies using less stringent methods are already available, and it was our intention to test whether results provided by such studies were replicable using co-integration techniques. Also, more advanced techniques are currently available, such as the Hilbert-Huang Transform, which is an evolution of traditional spectral analysis [51]. The implementation of such techniques in further studies is currently on our research agenda. Fifth and final, due to the nature of data collected and of the analysis implemented, we were not able to estimate the exact expenditure in public unemployment spending possibly able to avoid one suicide per year. Despite this, we provided practical information concerning the amount of public spending (namely, its annual growth) able to cancel the annual growth of the rate of suicide and possibly to reduce it, for higher amounts.

To conclude, we believe that the results of the present study may have significant policy implications, particularly with regard to their impact on the 'body economic', i.e., "a group of persons organized under a common set of economic policies; a people whose lives are collectively affected by these policies" [33], a concept which includes the health effect of economic policies, that should not be scotomized.

Compliance with ethical standards

The authors have no conflict of interest in connection with this study.

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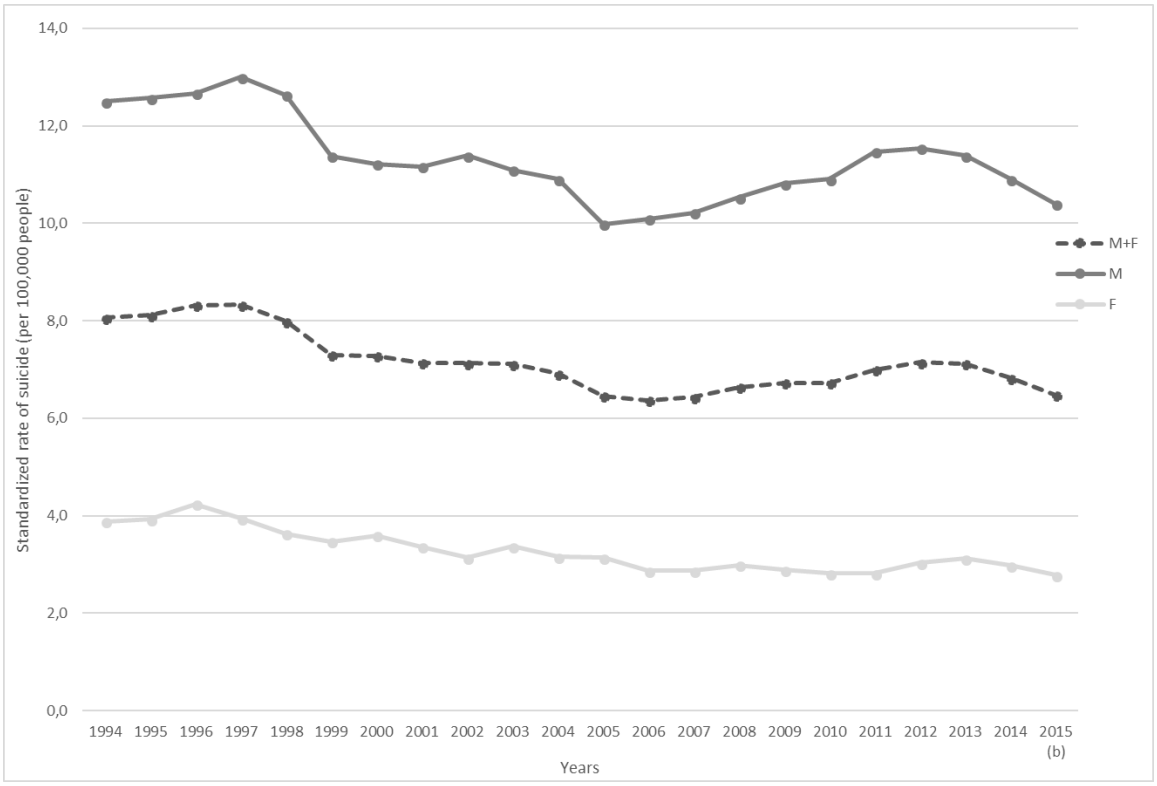

Figure. 1 –Suicide rates in Italy (years 1994-2015) (b) provisional datum.

Source: Istat [1]

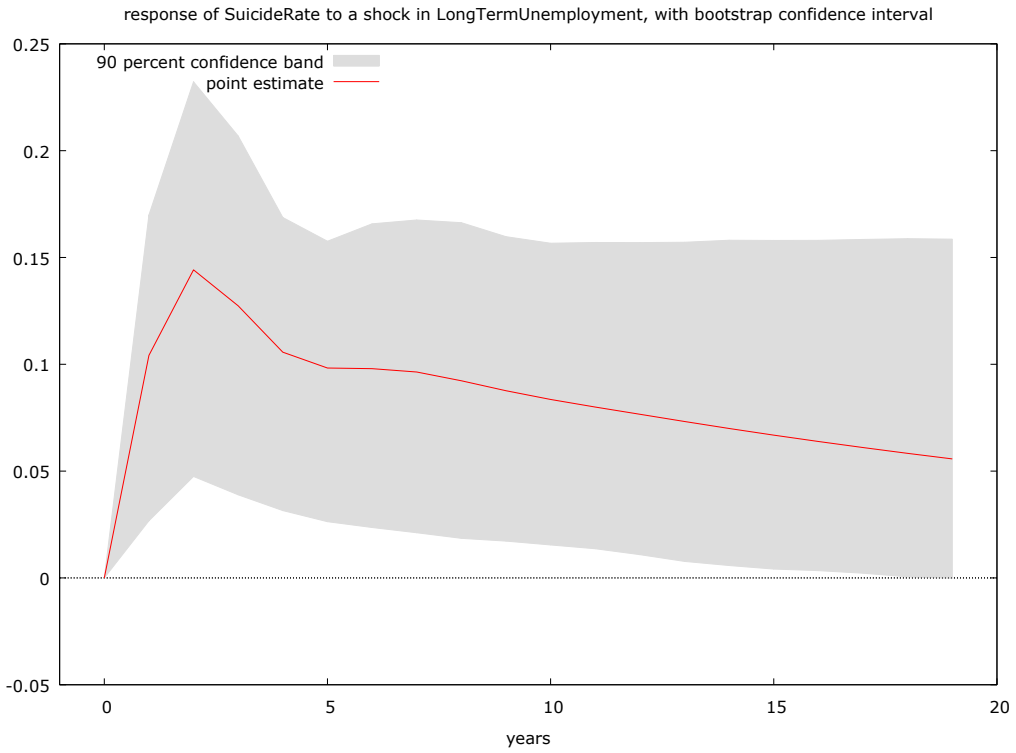

Figure 2: Impulse response function of the suicide rate to a one standard deviation shock in the long-term unemployment rate.

Table 1. Integration analysis

Variable	ADF Model Constant included	ADF Model Constant and trend included	Presence of unit roots	Degree of integration
S_t : suicide rate in logs	ADF(1): -0.84 (0.80)	ADF(0): -2.10 (0.54)	Yes	I(1)
S_t Male group	ADF(0):-1.41(0.56)	ADF(0):-1.37(0.35)	Yes	I(1)
S_t Female group	ADF(1): -0.35(0.91)	ADF(1):-1.22(0.90)	Yes	I(1)
UR_t : unemployment rate in logs	ADF(1): - 2.26 (0.18)	ADF(1): -2.76 (0.20)	Yes	I(1)
UR_t Male group	ADF(3): -2.25(0.18)	ADF(3): -2.91(0.15)	Yes	I(1)
UR_t Female group	ADF(1): -1.97(0.29)	ADF(1): -2.15(0.51)	Yes	I(1)
$LTUR_t$: long term unemployment rate in logs	ADF(0): - 1.06 (0.71)	ADF(0): -2.70 (0.23)	Yes	I(1)
$EXPN_t$: Social Expenditure for Unemployment / GDP (logs)	ADF(0): -1.60 (0.48)	ADF(0): - 0-61 (0.97)	Yes	I(1)

Note: ADF(p) indicates Augmented Dickey Fuller tests with differents lags p. BIC is used to choose the optimal lag length p. The null hypothesis is unit root. (.) P-values. I(1) means non stationary series (i.e., presence of at least one unit root).

Table 2. Cointegration analysis: results from Johansen estimation, VAR(2)

Cointegrating regression	**Trace test [p-values]**		**Max-eigenvalues [p-values]**	
$S_t = \alpha + \beta UR_t + u_t$	R=0	6.632 [0.626]	R= 0	6.518 [0.555]
	R<=1	0.114 [0.735]	R= 1	0.1142 [0.735]
Time span: 1977-2012				
$S_t = \alpha + \beta UR_t + u_t$	R=0	7.6823 [0.507]	R= 0	6.8939 [0.510]
	R<=1	0.78837 [0.375]	R= 1	0.78837 [0.375]
MALE group. Time span:1977-2012				
$S_t = \alpha + \beta UR_t + u_t$	R=0	5.9899 [0.700]	R=0	5.9136 [0.630]
	R<=1	0.076339 [0.782]	R=1	0.076339 [0.782]
FEMALE group. Time span: 1977-2012				
$S_t = \alpha + \beta UR_t + \phi trend + \varepsilon_t$	R=0	12.939 [0.249]	R= 0	10.401 [0.368]
	R<=1	2.5383 [0.111]	R= 1	2.538 [0.111]
Time span:1977-2012				
$S_t = \alpha + \beta UR_t + \phi trend + \varepsilon_t$	R=0	16.329 [0.094]	R= 0	9.6015 [0.443]
	R<=1	6.7277 [0.010]	R= 1	6.7277 [0.010]
MALE group. Time span:1977-2012				
$S_t = \alpha + \beta UR_t + \phi trend + \varepsilon_t$	R=0	20.338 [0.025]	R=0	15.535 [0.083]
	R<=1	4.8026 [0.028]	R=1	4.8026 [0.028]
FEMALE group. Time span: 1983-2012				
$S_t = \alpha + \beta LTUR_t + \eta_t$	R=0	15.427 [0.049] ^	R=0	12.353 [0.097]
	R<=1	3.0741 [0.079] **	R=1	3.074 [0.079]
Time span: 1983-2012				

Note: The Johansen estimation is from a system with an *unrestricted constant* corresponding to deterministic cointegration: the variables are cointegrated sharing common deterministic and stochastic trends. When an *unrestricted trend* is included in the cointegrating relationship we test for stochastic cointegration: the variables are cointegrated sharing only stochastic trends The VAR lag length is selected by BIC. pvalues for the cointegrating rank in [.] are computed by Doornik (1998).^ indicates that the null of r = 0 (no cointegration) is rejected at 5% significance level whereas ** indicates that the null of r =1 cointegrating vector is not rejected at 5%.

Table 3 Ordinary Least Square estimation of the ECM

Dependent variables: ΔS_t

Variables	ECM 1 (eq.3)	ECM2 (eq.4)
ΔS_{t-1}	0.34 (0.003) ***	0.35 (0.002)***
$\Delta LTUR_{t-1}$	0.21 (0.12)	0.26 (0.08)*
$\Delta EXPUN_{t-1}$		0.03 (0.18)
$\Delta EXPUN_{t-1} * \Delta LTUR_{t-1}$		−1.44 (0.00) ***
ECT_{t-1}	−0.14 (0.09)*	−0.11 (0.05)**
Adjusted R -squared	0.19	0.25
Jarque Bera for Normality	P-value = 0.48	P-value = 0.14

Note: ECM (Error Correction Model) is the following econometric specification of the data. $\Delta S_t = \sum_{i=1}^{m} a_i \Delta S_{t-i} + \sum_{j=1}^{n} b_j \Delta LTUR_{t-j} + ... + \delta(ECT)_{t-1} + \xi_t$. ΔS is the log differences in the suicide rate at t.-1 (i.e., the rate of growth of the suicide rate); $\Delta LTUR$ is the log differences in the long-term unemployment rate (i.e., the rate of growth of the long term unemployment rate); $\Delta EXPUN$ is the log differences in public unemployment spending (i.e., the rate of growth of public unemployment spending). ECT (error correction term) represents the long run relationship $S_t = 0.47 + 0.83 LTUR_t$ at t-1; it is jointly estimated in the ECM by the multivariate Johansen procedure. *, **, *** indicate 1%, 5%, 10% significance level respectively. The ECM lag length is selected by BIC. P-values of the coefficients in parenthesis. Standard errors HAC.

Table 4. An example of different marginal effects of a long-term unemployment increase (equal 1%) for different values of growth of the public unemployment spending possibly able to reduce the annual growth of the suicide rate, according to the following: $\frac{\Delta S_t}{\Delta LTUR_{t.-1}} = 0.26 - 1.44\Delta EXPUN_{t-1}$

Annual growth of the public unemployment spending	**Outcome expected**
$\Delta EXPUN = 0.18\%$	$\frac{\Delta S_t}{\Delta LTUR_{t.-1}} = 0$
$\Delta EXPUN = 0.20\%$	$\frac{\Delta S_t}{\Delta LTUR_{t.-1}} = 0.26 - 1.44 * 0.20 = -0.028$
$\Delta EXPUN = 0.30\%$	$\frac{\Delta S_t}{\Delta LTUR_{t.-1}} = 0.26 - 1.44 * 0.40 = -0.31$

Note: ECM ΔS is the log differences in the suicide rate at t-1 (i.e., the rate of growth of the suicide rate); $\Delta LTUR$ is the log differences in the long-term unemployment rate (i.e., the rate of growth of the long term unemployment rate); $\Delta EXPUN$ is the log differences in public unemployment spending (i.e., the rate of growth of public unemployment spending).